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Intake of Key Chronic Disease–Related Nutrients among Baby Boomers

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Abstract

Objectives—The dietary habits of baby boomers (people born between 1946 and 1964) undoubtedly will have a substantial impact on their future health; however, dietary information regarding the intake of key chronic disease–related nutrients is lacking for this generation. The objective of this study was to compare the dietary intake of key chronic disease–related nutrients of the baby boomer generation with the previous generation of middle-aged adults.

Methods—National cross-sectional study comparison analyzing data from the National Health and Nutrition Examination Survey (NHANES) including NHANES III (1988–1994) and the NHANES for 2007–2010, focused on adult respondents ages 46 to 64 years who were not institutionalized at the time of each survey. The two cohorts were compared with regard to dietary intake of key nutritional components. The main outcome measures were intake of total calories, sodium, cholesterol, fat, fruits, vegetables, vitamin C, water, and fiber.

Results—The baby boomers' average daily intake of nutrients exceeded that of the previous generation of middle-aged adults for total calories (2118/1999), total fat (82/76 g), sodium (3513/3291 mg), and cholesterol (294/262 g; all $P < 0.001$). The intake of vitamin C (105/89 g), water (1208/1001 g), and vegetables (199/229 g) was less than that of the previous generation ($P < 0.001$), and the dietary intake of fruit and fiber was unchanged. In regression analyses, dietary changes remained significant after controlling for age, race, sex, and socioeconomic status (all $P < 0.01$).

Conclusions—The study findings document higher dietary intake of key chronic disease–related nutrients along with reduced vegetable intake among baby boomers compared with the previous generation of middle-aged adults. These findings are indicative of a diet that may contribute to increased rates of chronic disease among individuals in this age group.

Keywords

baby boomers; dietary intake; sodium; dietary cholesterol; dietary fat

The health status of the baby boomer generation (people born between 1946 and 1964) has been questioned in several studies[1–3] that have shown mixed results, such as a lower smoking rate compared with previous generations of middle-aged adults. These studies also

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demonstrate several signs of poor health, such as increased rates of obesity, diabetes, hypertension, chronic disease, and disability.[1,4] The health of the baby boomer generation is critical to the nation's health for multiple reasons, including the large size of the baby boomer cohort, 78 million people[5] and the economic impact that the health of this generation will have as they age and inevitably experience declining health.

The dietary habits of baby boomers will have a substantial effect on the future health of this generation. As a result, increased chronic conditions such as obesity, hypertension, and hyperlipidemia and specific information regarding caloric intake, sodium intake, and fat/cholesterol intake in the baby boomer cohort will be extremely valuable; however, information regarding dietary intake, of key chronic disease–related nutrients is lacking for the baby boomer generation. More information is needed regarding the nutritional intake patterns of this population to direct policy makers and public health planners to improve the nation's health. The goal of this study was to compare the intake of key chronic disease–related dietary nutrients of the baby boomer generation with that of the previous generation of middle-aged adults.

Methods

We analyzed data from the National Health and Nutrition Examination Survey (NHANES), including the NHANES for 1988–1994 (NHANES III) and the NHANES for 2007–2010 (NHANES 2010), focusing on respondents who were 46 to 64 years old during either period[A], and the two cohorts were compared by dietary intake of key nutritional components.

The NHANES is a national survey series that began more than 40 years ago and is sponsored by the Centers for Disease Control and Prevention (CDC). The NHANES is conducted continuously across the nation in select locations using a series of multistage surveys in a complex sampling design to assess the health and nutritional status of the civilian noninstitutionalized population of the United States. It includes demographic, socioeconomic, dietary, and health-related information of survey respondents. Although both the NHANES III and the NHANES 2010 were designed to address the same aspects of the US population, they were conducted more than a decade apart and some of the survey questions differed. For the purposes of the present study, the variables chosen for analysis were as similar as possible in each cohort, with some recoding of variables in the surveys as necessary.

Demographics and Body Measurement Variables

Demographic characteristics including age, sex, race, socioeconomic status (SES), education level, and ratio of family income to poverty level were collected. Race was defined in four categories: non-Hispanic white, non-Hispanic black, Mexican American, and other. Education was transformed into a dichotomous variable of ≤11 years and >11 years of

[A] A 46-year-old person in 1988 would've been born in 1942 and a 64-year-old in 2007 would've been born in 1943, so they would not be boomers. (The sentence also seems to contradict the first sentence of the Results section.) Would you like to rephrase to "focusing on respondents who were in the baby boom age group during either period..."?

education completed. Body measurement variables such as height, weight, and body mass index (BMI) also were obtained. BMI categories were underweight (<18.5), normal weight (≥18.5 and ≤24.9), overweight (≥25 and ≤29.9), and obese (≥30), based on the CDC categories.

Dietary Intake Variables

Of two 24-hour dietary recalls collected in the NHANES 2010, only the first 24-hour recall interview was used for the purpose of comparison with the NHANES III, which collected only 1 day of dietary recall for respondents. Most of the dietary intake variables, including total energy, total fat, vitamin C, potassium, magnesium, carbohydrate, protein, calcium, potassium, sodium, cholesterol, and fiber, were extracted directly from the total nutrient intake of 1-day recall datasets (not including supplement intake). Variables such as vegetables, fruit, milk, and milk products were calculated by using the first digit of the NHANES DRXFDCD food code (eg, “1” for milk and milk products, “6” for fruits, “7” for vegetables) and adding the amount of the same kinds of food together in the datasets of individual foods of 1-day recall for each respondent. For water intake, different questions were asked in the NHANES III and the NHANES 2010; only the questions regarding plain water intake were used in the present study.

Statistical Analysis

Statistical analysis software (SAS version 9.3, SAS Institute, Cary, NC) was used for analysis in this study. To determine the appropriate sample weight to account for the complex survey design (including oversampling), survey nonresponse, and poststratification, the program specialist at the National Center for Health Statistics was consulted. All of the estimates for NHANES III were weighted using 6-year weights from the mobile examination center examination weights. For NHANES 2010, the dietary day 1 weights were used without constructing 4-year dietary weights because the same population was used to poststratify the sample weights. To correct for the complex sampling between the two NHANES periods, the CDC program specialists recommended the creation of a new strata variable by adding 49 to the original strata variable “sdmvstra” in the NHANES 2010 sample.

Descriptive analysis was conducted for demographic characteristics of the respondents. Differences in dietary intake, including total energy, total fat, protein, fiber, carbohydrate, vitamin C, calcium, cholesterol, sodium, potassium, water, fruit, vegetables, milk, and milk products, between the two NHANES eras were determined using procedure SURVEYMEANS and procedure SURVEYREG. Based on the finding of existing differences, a regression model was constructed to predict whether current baby boomers had an intake of key nutrients different from the previous generation of middle-aged adults, controlling for possible confounding factors, including age, race, sex, and SES. Poverty ratio, a proportion of the population that meets the definition of poverty, was used to represent SES.

One day of a 24-hour dietary recall was used for data collection and was considered important to address the possibility of overreporting or underreporting dietary intake by

respondents. The revised Goldberg method[6,7] was applied to evaluate overreporting or underreporting of dietary intake in both NHANES cohorts based on physical activity level (PAL) and compared with the ratio of self-reported energy intake to basal metabolic rate (rEI:BMR). BMR was calculated using the Mifflin equation, based on age, sex, height, and weight. PAL in the NHANES 2010 was determined based on answers to three questions regarding recreational activities in the past week: walking or bicycling, vigorous recreational activities, and moderate recreational activities.

For the NHANES III, PAL was determined in terms of the sum of all of the answers to the questions regarding respondents' recreational activities in the past month divided by 4.3 (average times per week, 22). Overreporters and underreporters were calculated based on correspondence of the reported rEI:BMR ratios with each subject's reported PAL, taking into account coefficients of variation in intakes and other components of energy balance. Lower and upper confidence interval (CI) limits were calculated for rEI:BMR ratios using plausible upper and lower limits based on the World Health Organization standard rEI:BMR ratios of 1.55 for light physical activity (women and men), 1.64/1.78 for moderate activity (women and men), and 1.82/2.10 for individuals with high physical activity (women and men); standard deviation levels used were −2/+2 for 95% CI limits.

After the lower and upper limit calculations were obtained for individuals in the study population, we compared their rEI/BMR ratios to the World Health Organization standard lower and upper confidence limits based on sex and PAL level. We reported as a underreporter if an individual rEI/BMR ratio was less than the lower limit and as an overreporter if an individual rEI/BMR ratio was greater than the upper limit. The mean for lower limit for rEI:BMR was 0.99 (95% CI 0.98–0.99) and for upper limit was 3.11 (95% CI 3.10–3.12). Individual respondents were classified based on their own lower and upper limits. We found that 38.8% of respondents were underreporters and <1% (0.87%) were overreporters.

Results

A total of 7438 respondents, 3866 from the NHANES III (generation of middle-aged adults before the baby boomers) and 3572 from the NHANES 2010 (baby boomers) were included in the analytic sample for this study. Table 1 contains the summaries of the demographic characteristics of the respondents in both cohorts. Age, sex proportion, and income status were comparable between the two groups. A greater proportion of baby boomers had completed ≥11 years of school (70.5% vs 55.1%) than the previous generation of middle-aged adults. Average weight and BMI were higher in baby boomers (Table 1).

The overall means of dietary intake, including total energy, total fat, protein, fiber, carbohydrate, vitamin C, calcium, cholesterol, sodium, potassium, magnesium, water, fruit, vegetables, milk, and milk products, were compared between baby boomers and the previous generation of middle-aged adults (Table 2). Baby boomers, on average, consumed significantly more total energy ($P < 0.001$), total fat ($P < 0.001$), protein ($P < 0.01$), calcium ($P < 0.001$), cholesterol ($P < 0.001$), and sodium ($P < 0.01$) but less vitamin C ($P < 0.01$), water ($P < 0.001$), and vegetables ($P < 0.01$) than the previous generation (Fig.). No

significant differences were found in the mean intake of fiber, carbohydrates, potassium, magnesium, fruit, and milk and milk products between baby boomers and the previous generation of middle-aged adults.

Taking into account the possibility that increases in sodium, fat, and other nutrients were related to the increase in total caloric intake among baby boomers, comparisons of overall means for dietary intake of key nutrients were adjusted for overall calories in Table 3. The results indicated that after the adjustment, no marked difference was found in the average intake of protein, fiber, cholesterol, sodium, magnesium, fruit, and milk and milk products between the two groups. Compared with the previous generation of middle-aged adults, baby boomers consumed significantly more total fat ($P < 0.05$) and calcium ($P < 0.001$) but less carbohydrates ($P < 0.001$), vitamin C ($P < 0.01$), potassium ($P < 0.0001$), water ($P < 0.001$), and vegetables ($P < 0.001$).

For the key nutrient factors that were statistically different for baby boomers, we investigated the differences (total calories, fat, sodium, cholesterol, vitamin C, calcium, water, and vegetables) between baby boomers and the previous generation of middle-aged adults using a regression analysis, controlling for age, race, sex, and SES (Table 4). The key nutrient differences remained significant after controlling for possible confounding by demographic and social factors.

Discussion

The present study assessed food intake across multiple dietary components, including total calories, total fruit, whole grains, dairy, total protein, and vegetables. The findings of this study indicate that baby boomers fall short of the goals of the 2010 *Dietary Guidelines for Americans*,[8] as indicated by higher fat, sodium, and caloric intake; lower vitamin C, water, and vegetables intake; and no demonstrable improvement in fiber consumption or other major nutrients.

Published studies have documented nutritional patterns in adults in the United States and elsewhere, but few have focused specifically on the baby boomer cohort.[1–3] In a study of metabolic profiles of adult men and women, researchers have identified three primary dietary clusters that distinctly contributed to total energy intake among participants.[9] The first cluster represented a significantly high energy contribution from breads and desserts; the second from snack foods and dairy products; and the third from white bread, sugars, butter, and red meat. The results of the present study similarly suggest habitual adherence to high-energy dietary intake, a significant increase in the total energy consumed by the baby boomer generation compared with the older cohort.

The higher intakes of total calories, fat, and cholesterol have significant implications for the burden of hypertension, diabetes, and obesity in the baby boomer group. In a study by Fock and Koo, multiple sources of evidence that support the importance of total dietary caloric intake in preventing and controlling diabetes and obesity were reviewed.[10] High sodium intake is a known contributor to hypertension and lowering sodium intake is a key part of the Dietary Approach to Stop Hypertension.[11] Dietary cholesterol and lipid metabolism are

significantly linked with obesity and insulin resistance.[12] Taken together, the higher intakes of total calories, fat, sodium, and cholesterol provide a heavy nutritional burden on the baby boomer generation and constitute a significant metabolic stress that contributes to chronic disease.

The lower intake of vegetables among baby boomers is a likely contributor to the trend of increased chronic metabolic disease in this population.[13] Similarly, a lower intake of vitamin C (<100 mg/day) is problematic given that the optimum intake of vitamin C is believed to be 20 μg/day.[14] Higher fruit, vegetable, and vitamin C intake is associated with less hypertension, better endothelial function, lower levels of oxidative stress, and reduced levels of chronic metabolic disease.[15,16] Although no single marker that includes vitamin C intake can totally reflect fruit intake, diets high in vitamin C are associated with the quality of the diet and decreased risk for several medical conditions, including obesity and heart failure.[17,18] The lower intake of vitamin C and vegetables in the baby boomer generation may represent a concerning pattern despite there being no difference in reported total fruit intake compared with the previous generation of middle-aged adults.

Several factors may explain the lower intake of key health-related nutrients among current baby boomers. Previous research has found food intake patterns to be related to SES; however, the current findings remained after adjusting for SES. In a longitudinal study conducted across 22 years, the dietary habits of Danish men and women were found to be significantly associated with SES.[19] Poor nutritional practices, such as high intakes of red meat, fast and snack foods, breads, potatoes, desserts, sauces, and sweetened soft drinks and juices were more common among men from the low SES group. Conversely, high SES men and women were more likely to consume greater amounts of fresh fruits and vegetables, poultry, fish, and whole grains. Leung and colleagues,[20] using NHANES data from 1999–2008, determined that low SES in the United States also was associated with poor dietary practices. They found that participants in a nutritional assistance program consumed larger amounts of meats, beans, total grains, and saturated fats than whole grains, fruit, green and orange vegetables, and legumes. In addition, they reported that one in five adults with low SES did not meet the 2010 *Dietary Guidelines for Americans* or the age- and sex-appropriate estimated average requirements or the adequate intakes for nutrients of the Institute of Medicine.

Other factors may explain a lower intake of key health-related nutrients in the baby boomer generation, and it has been suggested that declining vegetable intake may be partially explained by an overall reduction in farmland nationally, an increase in foods that are not particularly healthful, and a lack of federal programs or initiatives that promote balanced diets and healthy nutritional practices.[21] The availability of fast food and inexpensive, unhealthful food options has increased, and these foods often are overused by lower SES groups.[22]

Conversely, advances in agricultural science and improved shipping and trade modalities have eased general access throughout the year to such food items as fresh fruits and vegetables, fish, and whole grains. In the present study, adverse nutrient patterns persisted after controlling for SES, which may indicate that behavior and choices may be at least as

important as access to healthful foods. Indeed, Raynor and colleagues[23] observed that US adults continue to exceed recommended levels of fat intake, even while low- and reduced-fat foods are increasingly available.

The limitations of the present study include the cross-sectional nature of the data and the inconsistency in questions and how they were worded between the NHANES III and the NHANES 2010. Furthermore, the survey data on diet are self-reported based on a 24-hour recall, and although widely used as a population estimate of diet behavior for the US population, these data are not always indicative of the foods consumed by the participating individuals on a regular basis.

Conclusions

Our findings documenting increased total caloric, sodium, cholesterol, and fat intake, along with reduced vegetable intake among baby boomers, illustrate a decline in the intake of many key nutrients compared with the previous generation of middle-aged adults. These data provide at least a partial explanation for the increased rates of hypertension, diabetes, and hypercholesterolemia observed in the baby boomer generation as compared with 2 decades ago in individuals of the same age.[1] Improving baby boomers' dietary intake of key nutrients may offer an opportunity to address rising healthcare costs in that generation,[24,25] given the link between healthy dietary habits and subsequent health in middle-aged adults.[26] Lastly, the study reveals a noteworthy need for expanded efforts directed toward the promotion of healthy eating in this population.

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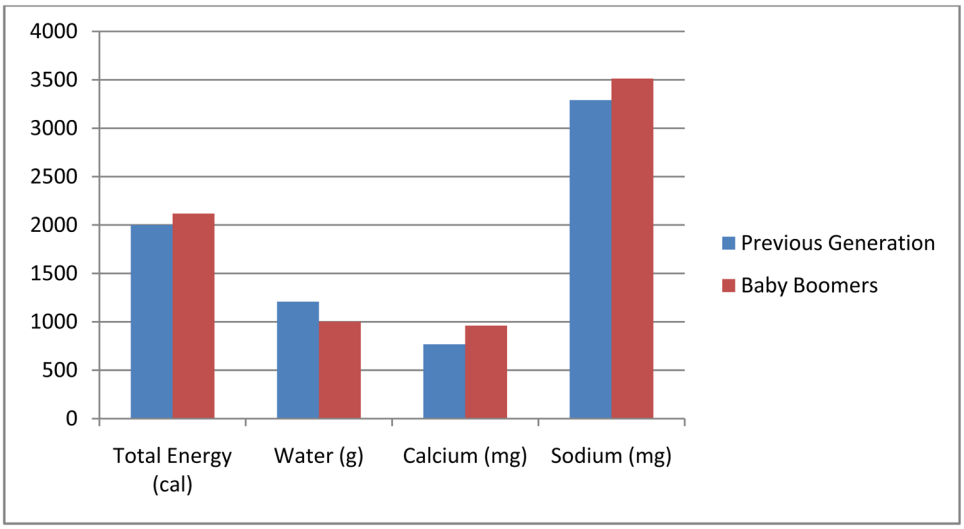
Key Points

- Baby boomers consume more calories, fat, sodium, and cholesterol than did the previous generation at the same age.
- Baby boomers eat fewer vegetables and consume less water and vitamin C than did the previous generation of middle-aged adults.
- In regression analyses, the changes in nutrient intake were not related to age, sex, or socioeconomic status.

A



B

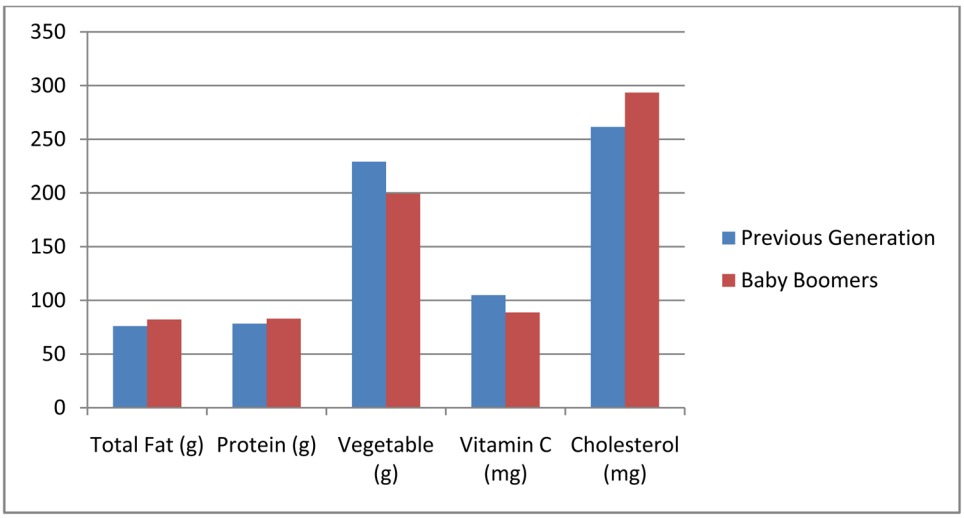


Fig.

Selected nutrient intakes by baby boomers and the previous generation of middle-aged adults.[B]

[B]Because the original 2 figs had the same caption, they were combined into a single figure with A and B panels. Pls add caption text distinguishing part A from part B.

Table 1

Demographic characteristics of the baby boomer generation and the previous generation of middle-aged adults, NHANES III (1988–1994) and NHANES 2010 (2007–2010)

Characteristic	NHANES III (n = 3866)[a]	NHANES 2010 (n=3572) [a]
Age, mean ± SD, y	55.32 ± 5.65	55.02 ± 5.56
Sex, %		
Male	47.72	49.69
Female	52.28	50.31
Height, cm, mean ± SD	166.75 ± 9.63	167.62 ± 10.15
Weight, kg, mean ± SD	78.67 ± 17.43	84.23 ± 20.98
Race, %		
Mexican American	25.01	18.73
Non-Hispanic white	44.05	43.42
Non-Hispanic black	26.23	21.84
Other	4.71	16.01
Body mass index, %		
Underweight (<18.5)	1.55	1.49
Normal weight (≥18.5 and ≤24.9)	28.43	20.84
Overweight (≥25 and ≤29.9)	37.48	34.21
Obese (≥30)	32.54	43.46
Family income:poverty level, mean ± SD	2.79 ± 1.95	2.77 ± 1.70
Education, y, %		
≤11	44.86	29.54
>11	55.14	70.46

NHANES, National Health and Nutrition Examination Survey; SD, standard deviation.

[a]Unweighted.

Table 2

Means of unadjusted dietary intakes between the baby boomer generation and the previous generation of middle-aged adults, NHANES III (1988–1994) and NHANES 2010 (2007–2010)

	Means (95% CI)			
Dietary intakes	**NHANES III**	**NHANES 2010**	**β (SE)**	***P*[a]**
Total energy, cal	1998.90 (1958.21–2039.59)	2118.25 (2066.20–2170.29)	119.35 (33.21)	0.0006***
Total fat, g	76.01 (73.57–78.45)	82.20 (79.67–84.73)	6.19 (1.77)	0.0008***
Protein, g	78.32 (76.41–80.22)	82.93 (80.75–85.10)	4.61 (1.45)	0.0021**
Fiber, g	16.73 (16.23–17.22)	17.13 (16.31–17.95)	0.40 (0.48)	0.4087
Carbohydrate, g	243.98 (238.08–249.88)	249.79 (244.11–255.46)	5.81 (4.12)	0.1620
Vitamin C, mg	104.88 (95.12–114.63)	88.71 (82.31–95.12)	−16.16 (5.87)	0.0073**
Calcium, mg	767.56 (741.60–793.52)	960.72 (927.76–993.67)	193.16 (21.09)	<0.0001***
Cholesterol, mg	261.51 (250.70–272.33)	293.51 (280.52–306.51)	32.00 (8.50)	0.0003***
Sodium, mg	3290.97 (3175.22–3406.72)	3513.16 (3412.90–3613.42)	222.19 (76.97)	0.005**
Potassium, mg	2902.77 (2833.77–2971.77)	2860.17 (2777.20–2943.14)	−42.60 (54.24)	0.4345
Magnesium, mg	302.04 (295.48–308.61)	310.79 (301.26–320.31)	8.74 (5.82)	0.1367
Water, g	1208.00 (1144.72–1271.28)	1001.23 (935.47–1066.98)	−206.77(45.87)	<0.0001***
Fruit, g	170.49 (156.53–184.45)	169.29 (157.13–181.45)	−1.20 (9.31)	0.8981
Vegetable, g	229.12 (216.72–241.52)	199.39 (187.13–211.64)	−29.73 (8.76)	<0.0011**
Milk and milk products, mL	240.09 (225.76–254.43)	235.60 (217.75–253.46)	−4.49 (11.51)	0.6974

*$P < 0.05$;

**$P < 0.01$;

***$P < 0.001$.

CI, confidence intervals; NHANES, National Health and Nutrition Examination Survey; SE, standard error.

[a]*P* value comparing the difference of means of unadjusted dietary intakes.

Table 3

Means of adjusted dietary intakes between the baby boomer generation and the previous generation of middle-aged adults, NHANES III (1988–1994) and NHANES 2010 (2007–2010)

	Means (95% CI)			
Dietary intakes	**NHANES III**	**NHANES 2010**	**β (SE)**	***P*[a]**
Total fat, g	36.94 (36.24–37.64)	37.89 (37.47–38.31)	0.95 (0.41)	0.0229*
Protein, g	40.05 (39.50–40.60)	40.09 (39.46–40.72)	0.04 (0.42)	0.9275
Fiber, g	8.81 (8.60–9.02)	8.57 (8.24–8.91)	−0.23 (0.20)	0.2488
Carbohydrate, g	124.44 (122.83–126.05)	120.40 (118.8–122.01)	−4.04 (1.14)	0.0007***
Vitamin C, mg	56.34 (52.17–60.52)	46.36 (42.2–50.52)	−9.98 (2.96)	0.0012**
Calcium, mg	396.09 (384.78–407.40)	472.42 (459.67–485.18)	76.33 (8.57)	<0.0001***
Cholesterol, mg	132.06 (127.41–136.72)	137.28 (132.41–142.15)	5.22 (3.38)	0.1271
Sodium, mg	1673.84 (1638.70–1708.98)	1702.38 (1667.90–1736.85)	28.54 (24.74)	0.2521
Potassium, mg	1532.54 (1501.35–1563.72)	1424.73 (1388.41–1461.04)	−107.81 (24.06)	<0.0001***
Magnesium, mg	157.99 (154.62–161.37)	154.79 (151.12–158.47)	−3.20 (2.51)	0.2059
Water, g	755.41 (710.11–800.70)	594.24 (549.44–639.03)	−161.17 (32.02)	<0.0001***
Fruit, g	95.38 (88.22–102.53)	88.46 (82.01–94.91)	−6.92 (4.84)	0.1569
Vegetable, g	125.99 (118.75–133.23)	103.39 (97.59–109.19)	−22.60 (4.66)	<0.0001***
Milk and milk products, g	123.90 (116.85–130.94)	115.50 (107.03–123.97)	−8.39 (5.54)	0.1335

*$P < 0.05$;

**$P < 0.01$;

***$P < 0.001$.

CI, confidence intervals; NHANES, National Health and Nutrition Examination Survey; SE, standard error.

[a]*P* value comparing the difference of means of unadjusted dietary intakes.

Table 4

Linear regression estimates for comparing unadjusted dietary intakes of the baby boomer generation with the previous generation of middle-aged adults, controlling for age, sex, race, and poverty ratio

Dietary intakes[A]	β	SE	*P*
Total energy	116.79	32.86	0.0006***
Total fat	6.62	1.81	0.0005***
Protein	4.66	1.42	0.0016**
Vitamin C	−16.79	6.12	0.0075**
Calcium	207.30	19.90	<0.0001***
Cholesterol	32.62	8.81	0.0004***
Sodium	222.13	79.24	0.0063**
Water	−203.02	47.05	<0.0001***
Vegetable	−25.31	9.28	0.0078**

*$P < 0.05$;

**$P < 0.01$;

***$P < 0.001$. SE, standard error.

[A]Should there be unit values in this column (eg, g, mg), as in previous tables?